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CLAIMS

1 1. A method for assessing adequacy of message flow
2 testing, comprising:

3 defining coverage criteria for testing a message
4 flow through a set of message flow elements;

5 determining a message-flow-coverage-goal for the
6 message flow with respect to the coverage criteria;

7 designing a test suite responsive to the message-
8 flow-coverage-goal;

9 applying the test suite to the message flow to
10 generate a coverage result for the set of message flow
11 elements; and

12 comparing the coverage result with the message-flow-
13 coverage-goal.

1 2. A method according to claim 1, wherein the
2 message flow comprises a message-oriented software
3 program wherein a message is a primary architectural
4 element.

1 3. A method according to claim 1, wherein the
2 message flow is comprised in a message-oriented
3 middleware application.

1 4. A method according to claim 1, wherein the
2 message flow comprises a visual program describing
3 processing logic as a directed graph and wherein the
4 message flow comprises an independent function, outside
5 of a message sender or message receiver.

1 5. A method according to claim 1, wherein the
2 message flow comprises a program processing a message
3 produced by an application chosen from one of a group of
4 applications comprising a client application and a server
5 application.

1 6. A method according to claim 5, wherein the

application comprises a message-sending-application and a message-receiving-application executing on different hardware platforms.

7. A method according to claim 6, wherein the message-sending-application and the message-receiving-application are implemented using different software and architectural paradigms.

8. A method according to claim 1, wherein the message flow elements comprise at least one element chosen from messages, nodes, connections, terminals, statements, conditions, external resources, and exceptions.

9. A method according to claim 1, wherein defining the coverage criteria comprises selecting a coverage model from at least one of processing node coverage, terminal coverage, connection coverage, path coverage, N-node coverage, statement coverage, multiple condition coverage, exception coverage, external resources coverage, and message content coverage.

10. A method according to claim 1, wherein determining the message-flow-coverage-goal comprises establishing a required coverage level for at least one of the coverage criteria.

11. A method according to claim 1, wherein applying the test suite to the message flow comprises:

performing an execution of at least a part of the test suite; and

evaluating an attained coverage level resulting from the execution.

12. A method according to claim 11, wherein evaluating the attained coverage level comprises:

visiting one or more nodes during the execution of

4 the at least part of the test suite;
5 comparing a number of processing nodes visited to a
6 total number of all processing nodes in the message flow;
7 and
8 computing a processing node coverage metric
9 responsive to the comparison.

1 13. A method according to claim 12, wherein
2 visiting the one or more nodes comprises entering a
3 simple node.

1 14. A method according to claim 12, wherein
2 visiting the one or more nodes comprises entering a
3 compound node and visiting zero or more nodes in a
4 constituent sub-flow.

1 15. A method according to claim 11, wherein
2 evaluating the attained coverage level comprises:

3 traversing one or more terminals during the
4 execution of the at least part of the test suite;

5 comparing a number of processing node terminals
6 traversed to a total number of processing node terminals
7 in the message flow; and

8 computing a terminal coverage metric responsive to
9 the comparison.

1 16. A method according to claim 11, wherein
2 evaluating the attained coverage level comprises:

3 traversing one or more connections during the
4 execution of the at least part of the test suite;

5 comparing a number of connections traversed to a
6 total number of connections in the message flow; and

7 computing a connection coverage metric responsive to
8 the comparison.

1 17. A method according to claim 11, wherein
2 evaluating the attained coverage level comprises:

selecting a group of one or more sets of N-nodes from the message flow, wherein N comprises any whole number less than or equal to a total number of nodes in the message flow;

performing at least one execution of the message flow so as to determine a number of nodes visited in each of the one or more sets during the at least one execution;

generating a respective set coverage result for each of the one or more sets, responsive to the number of nodes visited;

determining a number of covered-sets, responsive to the set coverage results;

comparing the number of covered-sets to a total number of sets in the group; and

computing an N-node coverage metric responsive to the comparison.

18. A method according to claim 11, wherein evaluating the attained coverage level comprises:

performing zero or more runtime exceptions during the execution of the at least part of the test suite;

comparing a number of runtime exceptions performed to a total number of all runtime exceptions in the message flow; and

computing an exception coverage metric responsive to the comparison.

19. A method according to claim 11, wherein evaluating the attained coverage level comprises:

visiting zero or more failure terminals during the execution of the at least part of the test suite;

comparing a number of failure terminals visited to a total number of all failure terminals in the message flow; and

computing an exception coverage metric responsive to the comparison.

20. A method according to claim 11, wherein evaluating the attained coverage level comprises:

executing zero or more node statements at least once during the execution of the at least part of the test suite;

comparing a number of node statements executed to a total number of node statements in the message flow; and

computing a statement coverage metric responsive to the comparison.

21. A method according to claim 20, wherein computing the statement coverage metric comprises comparing a number of node statements executed in a single node to a total number of node statements in the single node.

22. A method according to claim 20, wherein computing the statement coverage metric comprises comparing a number of node statements executed in a compound node's constituent sub-flows to a total number of node statements in the compound node's constituent sub-flows.

23. A method according to claim 11, wherein evaluating the attained coverage level comprises:

assessing an achievement of true and false values for each of zero or more boolean sub-expressions independently during the execution of the at least part of the test suite;

comparing the achievement for the one or more boolean sub-expressions to a total number of boolean sub-expression values possible in the message flow; and

computing a multiple condition coverage metric responsive to the comparison.

12 24. A method according to claim 23, wherein
13 computing the multiple condition coverage metric
14 comprises comparing a number of achieved true and false
15 values for zero or more boolean sub-expressions in a node
16 to a total number of boolean sub-expression values
17 possible in the node.

1 25. A method according to claim 23, wherein
2 computing the multiple condition coverage metric
3 comprises comparing a number of achieved true and false
4 values for zero or more boolean sub-expressions in a
5 compound node's constituent sub-flows to a total number
6 of boolean sub-expression values possible in the compound
7 node's constituent sub-flows.

1 26. A method according to claim 11, wherein
2 evaluating the attained coverage level comprises:
3 assessing a number of values assumed by each of one
4 or more fields in a message during the execution of the
5 at least part of the test suite;
6 comparing the number of values assumed to a total
7 number of possible values for each field in the message;
8 and
9 computing a message content coverage metric
10 responsive to the comparison.

1 27. A method according to claim 26, and comprising
2 computing a strong message content coverage metric
3 wherein the total number of values possible for each
4 field in the message comprises a cross product of the
5 message fields with their possible values.

1 28. A method according to claim 26, and comprising
2 computing a weak message content coverage metric wherein
3 the total number of values possible for each field in the
4 message comprises a sum of the number of possible values
5 for each message field independently.

29. A method according to claim 11, wherein evaluating the attained coverage level comprises:

- traversing one or more paths during the execution of the at least part of the test suite;
- comparing a number of paths traversed to a total number of paths in the message flow; and
- computing a path coverage metric responsive to the comparison.

30. A method according to claim 11, wherein evaluating the attained coverage level comprises:

- performing zero or more types of accesses to an external resource during the execution of the at least part of the test suite;
- comparing a number of types of accesses performed to a total number of types of accesses in the message flow; and
- computing a external resources coverage metric responsive to the comparison.

31. A method according to claim 1, wherein designing the test suite responsive to the message-flow-coverage-goal comprises:

- identifying an initial test suite for the message flow;
- assessing a coverage level achieved by the initial test suite; and
- adding additional tests to the initial test suite so as to increase the coverage level.

32. A method according to claim 1, wherein applying the test suite comprises generating message-flow-coverage-reports.

33. A method according to claim 29, and comprising integrating the message-flow-coverage-reports into a

visual message flow development environment.

34. A method according to claim 1, and comprising reporting coverage graphically using at least one graphical element chosen from a set of color, shading, highlighting, graphing, fonts, line styles, icons, and labels.

35. A method according to claim 1, and comprising reporting coverage via at least one medium chosen from hard-copy media and electronic media.

36. A method according to claim 1, wherein generating the coverage result comprises collecting coverage data using at least one method of data collection chosen from message flow instrumentation and data logging.

37. Apparatus for assessing adequacy of message flow testing, comprising a computer system which is adapted to define coverage criteria for testing a message flow through a set of message flow elements, determine a message-flow-coverage-goal for the message flow with respect to the coverage criteria, design a test suite responsive to the message-flow-coverage-goal, apply the test suite to the message flow to generate a coverage result for the set of message flow elements, and compare the coverage result with the message-flow-coverage-goal.

38. A computer software product for assessing adequacy of message flow testing, comprising a computer-readable medium having computer program instructions recorded therein, which instructions, when read by a computer, cause the computer to define coverage criteria for testing a message flow through a set of message flow elements, determine a message-flow-coverage-goal for the message flow with respect to the coverage criteria,

9 design a test suite responsive to the message-flow-
10 coverage-goal, apply the test suite to the message flow
11 to generate a coverage result for the set of message flow
12 elements, and compare the coverage result with the
13 message-flow-coverage-goal.

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